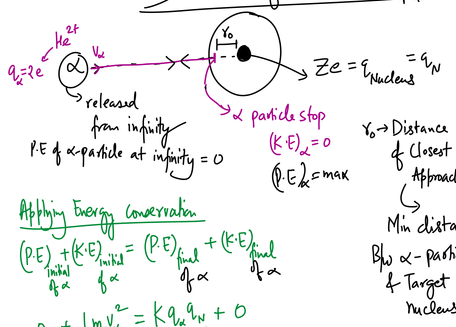
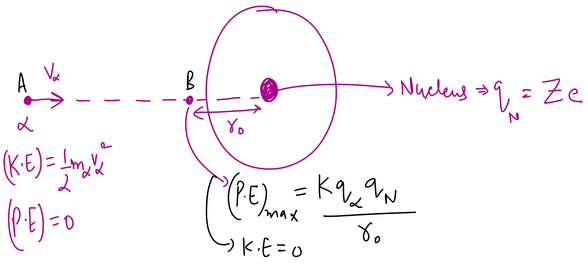
Distance of Closest Approach



$r_0 \rightarrow$ Distance of Closest Approach $\rightarrow$ Min distance Btw α-particle & Target Nucleus.



$(K.E) = \frac{1}{2} m_\alpha v_\alpha^2$

$(P.E) = 0$

$(P.E)_{max} = \frac{K q_\alpha q_N}{r_0}$

$K.E = 0$

Applying Energy conservation

$(P.E)_{\substack{initial \\ of \alpha}} + (K.E)_{\substack{initial \\ of \alpha}} = (P.E)_{\substack{final \\ of \alpha}} + (K.E)_{\substack{final \\ of \alpha}}$

$0 + \frac{1}{2} m_\alpha v_\alpha^2 = \frac{K q_\alpha q_N}{r_0} + 0$

$\frac{1}{2} m_\alpha v_\alpha^2 = \frac{K q_\alpha q_N}{r_0}$

$m_\alpha = 4\,amu = 4 \times 1.66 \times 10^{-27}\ kg$

$K = 9 \times 10^9\ \frac{N m^2}{C^2}$

$r_0 = \frac{2 K q_\alpha q_N}{m_\alpha v_\alpha^2}$ Distance of closest approach.

$r_0 = \frac{K q_\alpha q_N}{(K.E)_\alpha}$

Gold Nucleus $\Rightarrow q_{Au} = 79e$ (Au)

Copper Nucleus $\Rightarrow q_{Cu} = 29e$ (Cu)

Silver Nucleus $\Rightarrow q_{Ag} = 47e$ (Ag)

(*) Charged particle is accelerated under potential difference of V volts, then K.E of particle would be = qV

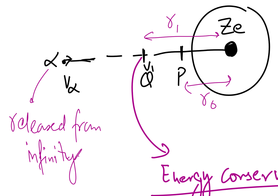
(*) $K.E = \frac{1}{2} m v^2 = \frac{1}{2} \frac{m^2 v^2}{m} = \frac{p^2}{2m}$

(momentum) $p = mv$

$p^2 = 2m(K.E)$

$p = \sqrt{2m(K.E)}$

Note



$r_0 \rightarrow$ distance of closest Approach

Energy conservation b/w initial & point Q

$0 + \frac{1}{2} m_\alpha v_\alpha^2 = \frac{K q_\alpha q_N}{r_1} + \frac{1}{2} m_\alpha v_1^2$

$v_1 \rightarrow$ velocity of α-particle at point Q

Observations from Rutherford's Experiment	Remarks / Conclusions
1) Most of the α-particles passed without any deflection	Most of the space inside atom is empty
2) Few α-particles deflected with small angles and very very few α-particles (1 out of 20000) deflected with angle $\geq 90^\circ$	Total positive charge and mass of atom is Concentrated in a very small region Called NUCLEUS.

Rutherford's Model of Atom

1. Nucleus of atom contains neutrons and protons which are collectively called Nucleons.
   e⁻s revolve around Nucleus like planets revolve around Sun i.e. this model is called Planetary Model of atom
2. Total mass of atom is concentrated in its Nucleus.
3. Radius of any Nucleus $(R) = R_0 (A)^{1/3}$

$A \rightarrow$ Mass No.

$R_0 \rightarrow$ Radius of H-atom

$\hookrightarrow 1.3\ fm = 1.3 \times 10^{-15}\ m$

fm $\rightarrow$ femtometer

Some important terms related to Nucleus

$^A_Z X$ — A: mass No; Z: Atomic No.

$Z = n_p = n_e$

$A - Z = n_n$